



EXTREME ULTRAVIOLET LITHOGRAPHY

1. Title:	Extendibility Using EUV Actinic Inspection Tool for sub-32-nm node													
2. Full names of all authors:	1. Sungmin Huh, 2. Stefan Wurm, 3. Hakseung Han 4. Kenneth Goldberg, 5. Iacopo Mochi													
3. For all authors: Company affiliation, e-mail, phone number, fax number, mailing address	<p>(1) SEMATECH Sungmin.Huh@SEMATECH.org Phone: 518.956.7439, Fax: 518.956.7151 255 Fuller Road, Suite 309 Albany, NY 12203</p> <p>(2) SEMATECH Stefan.Wurm@SEMATECH.Org Phone: 518.956.7144, Fax: 518.956.7151 255 Fuller Road, Suite 309 Albany, NY 12203</p> <p>(3) Samsung Electronics, hakseung.han@samsung.com Phone: (82) 31.208.4015, Fax: (82) 31.208.3019 Photomask Team, Samsung Electronics Co., LTD San#16, Banwol-Dong, Hwasung-city, Gyeonggo-Do, Korea, 445-701</p> <p>(4) Lawrence Berkeley National Laboratory kagoldberg@lbl.gov Phone: 510-843-8718 Fax: 510-486-4550 Center for X-Ray Optics, Lawrence Berkeley National Laboratory, Berkeley, CA 94720</p> <p>(5) Lawrence Berkeley National Laboratory imochi@lbl.gov Phone: 510-843-8718 Fax: 510-486-4550 Center for X-Ray Optics, Lawrence Berkeley National Laboratory, Berkeley, CA 94720</p>													
4. Presenting author:	Sungmin Huh													
5. EUVL topic (check only one by "X")	<table border="0"> <tr> <td><input type="checkbox"/> Exposure Tools (ET)</td> <td><input type="checkbox"/> Optics & ML Coatings (ML)</td> </tr> <tr> <td><input type="checkbox"/> Sources (SO)</td> <td><input type="checkbox"/> Optics Contamination (OC)</td> </tr> <tr> <td><input type="checkbox"/> Resists (RE)</td> <td><input type="checkbox"/> Device Integration (DE)</td> </tr> <tr> <td><input type="checkbox"/> Masks (MA)</td> <td><input type="checkbox"/> Technology Readiness (TR)</td> </tr> <tr> <td><input checked="" type="checkbox"/> Defect Inspection (DI)</td> <td><input type="checkbox"/> Cost of Ownership (CO)</td> </tr> <tr> <td><input type="checkbox"/> Reticle Contamination (RC)</td> <td></td> </tr> </table>		<input type="checkbox"/> Exposure Tools (ET)	<input type="checkbox"/> Optics & ML Coatings (ML)	<input type="checkbox"/> Sources (SO)	<input type="checkbox"/> Optics Contamination (OC)	<input type="checkbox"/> Resists (RE)	<input type="checkbox"/> Device Integration (DE)	<input type="checkbox"/> Masks (MA)	<input type="checkbox"/> Technology Readiness (TR)	<input checked="" type="checkbox"/> Defect Inspection (DI)	<input type="checkbox"/> Cost of Ownership (CO)	<input type="checkbox"/> Reticle Contamination (RC)	
<input type="checkbox"/> Exposure Tools (ET)	<input type="checkbox"/> Optics & ML Coatings (ML)													
<input type="checkbox"/> Sources (SO)	<input type="checkbox"/> Optics Contamination (OC)													
<input type="checkbox"/> Resists (RE)	<input type="checkbox"/> Device Integration (DE)													
<input type="checkbox"/> Masks (MA)	<input type="checkbox"/> Technology Readiness (TR)													
<input checked="" type="checkbox"/> Defect Inspection (DI)	<input type="checkbox"/> Cost of Ownership (CO)													
<input type="checkbox"/> Reticle Contamination (RC)														
6. Presentation preference:	<input checked="" type="checkbox"/> oral	<input type="checkbox"/> poster												

7. Abstract body:

SEMATECH operates the Actinic Inspection Tool (AIT) at Lawrence Berkeley National Laboratory (LBNL), a dual mode EUV microscope dedicated to mask research. The AIT uses scanning mode for inspection of defects on multilayer blanks, and zoneplate microscope imaging mode to record EUV aerial images through focus of regions of interest. The AIT's multiple zoneplates are designed to emulate the spatial resolution of 0.25–0.35 NA 4x EUV lithography tools.

SEMATECH also operates a Lasertec M7360 with sensitivity to multilayer defects down to ~40–45 nm, which is not sufficient for mask blank development below the 32-nm node. EUV mask blanks with real phase defects are inspected using the M7360 and the AIT in scanning mode to compare defect sensitivities. After scanning mode, each defect is reviewed using imaging mode with different NA values.

Actinic imaging provides quantitative aerial image feedback in ways that photoresist printing and non-EUV inspection methods cannot. From the resist image, most of contrast is lost in resist blurring and flare. So, it is very difficult to define a 20-nm half-pitch pattern in the current Micro Exposure Tool (MET), despite the short EUV wavelength. However the aerial image from AIT can resolve features below 100 nm CD on the mask. Thus the AIT makes it possible to study EUV masks for sub-32-nm half pitch nodes.